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ABSTRACT

Ninety-three preservice elementary teachers volunteered to participate in an investigation designed to study and change their attitudes toward science teaching. The purpose of the investigation was to: (1) test a persuasive communication that had been designed using Hovland's framework, (2) question the relevance of the consistency principle for attitude change instruction, and (3) determine what effect the individual difference variable integrative complexity had on the degree of attitude change when subjects were presented with integrated and non-integrated treatments. Results indicated that presentation of the persuasive communication model did effect a change in attitude for both the integrated and non-integrated treatment groups, although there was no significant difference in the magnitude of the change in attitude between the two groups. Both treatments were, apparently, equally effective. Further results indicate that as little as 20 minutes of persuasive communication can change the attitude toward teaching science. (MER)

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TITLE: The Systematic Design of a Persuasive Communication for Changing Attitudes of Preservice Teachers Toward Science

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THE SYSTEMATIC DESIGN OF A PERSUASIVE COMMUNICATION FOR CHANGING ATTITUDES OF PRESERVICE TEACHERS TOWARD SCIENCE

by

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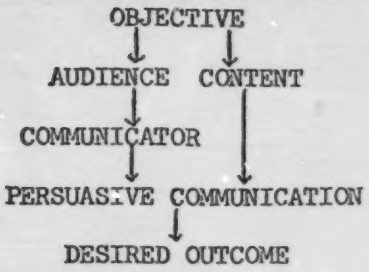
Paul W. Welliver

Robert L. Shrigley

Although attitudes have been investigated for over one hundred years, there is still much to be learned about the systematic design of instructional persuasive communications (Gabel, 1979). When the instructional development literature is searched for guidelines and research support for the systematic design of instruction in the affective domain, not much empirical evidence is found for the advice that is given. What is needed then is for attitude theory to be operationalized into an instructional design model and tested to be useable by educators and instructional developers.

The purpose of this investigation was threefold: (1) to test a persuasive communication that had been designed using Hovland's framework; (2) to question the relevance of the consistency principle for attitude change instruction; and (3) to determine what effect the individual difference variable integrative complexity had on the degree of attitude change when subjects were presented with integrated and non-integrated treatments.

Carl Hovland's persuasive communication model has been described as being based on stimulus-response learning theory and described with a four-part question: "Who says what to whom with what effect?" (Hovland, 1953). This framework can be translated into a flow diagram:



After defining one's objective, in terms of changing some specified attitude, one must look carefully at the audience characteristics to determine who would be a believable role model - credible communicator. Next one must also look carefully at the content to determine what would be a believable communication.

Much theoretical research has been conducted in using this model for changing the attitude of preservice teachers toward science teaching. Since several studies reported that elementary teachers have a negative attitude toward teaching science, Shrigley, a science teacher himself, conducted a series of investigations following Hovland's framework to create a theoretical persuasive communication to change this negative attitude to a more positive one. In identifying the essential elements, Shrigley (1978) made the following assumptions:

1. The "who" is the science educator, the communicator
2. The "what" is the formal, persuasive oral or written communication concerning the role of science learnings in the life of the American child
3. "Whom" is the recipient of the communication, those preparing to teach science in the elementary school
4. and "what effect" would be the change in behavior, the learned result on the part of the teachers; the response

Investigating the first part of the four-part question, Shrigley (1976) polled elementary education majors to identify characteristics of a science communicator who would be perceived as credible. The results indicated the following perceived characteristics:

1. Refers to practical teaching activities in class

2. Has taught science to children
3. Assumed responsibility for teaching science content
4. Models teaching modes similar to those proposed for children
5. Assists science professors in designing science courses
6. Counsels student teachers
7. Assists inservice teachers (p. 451)

In 1978, Shrigley also investigated the second part of Hovland's four part question to establish the content of a credible communication. By polling science educators across the United States, he was able to identify the following six major catagories of this content:

1. Science develops logical and critical thought, a means to independent learning.
2. Science provides the active, hands-on experience necessary for children to practice inquiry skills.
3. Science is motivating; it enhances the curiosity of children.
4. Science supports and enriches other areas of the elementary school curriculum.
5. Science learnings are necessary for coping with the crises in our technological society.
6. Science provides the child a necessary conceptual understanding of the physical and natural environment. (p. 337)

The "whom" was left simply as preservice elementary teachers. To determine the "what effect", he (1974a, 1974b) designed the Shrigley Attitude Scale for Preservice Teachers, a Likert type scale which measures science attitude. In this development, science attitude was divided into two parts: attitude toward science and attitude toward science teaching. Both parts were claimed to affect science attitude. Through factor analysis, the parts were broken down even further into four attitude components: "(1) science interest, (2) handling equipment, (3) science courses and (4) antipathy toward science" (Shrigley, 1974b).

To determine the actual effect of this theoretical example, the characteristics of the credible communicator and the content were woven into a persuasive communication and pre and post attitudes were measured by the Shrigley Attitude Scale for Preservice Teachers. This is graphically represented in Figure 1:

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL

	WHO	WHAT	WHOM	WHAT EFFECT
SHRIGLEY SCIENCE ATTITUDE MODEL	X 6 variables	X 6 components		X 4 factors

FIGURE I

SHRIGLEY'S THEORETICAL SCIENCE EXAMPLE MAPPED ONTO HOVLAND'S FRAMEWORK

Whereas this persuasive communication approach to attitude change deals specifically with teaching pertinent facts relevant to the attitude, it does not establish relationships between the cognitive components and the attitudes to which they are related. These relationships need to be considered in light of current instructional design theory. Effective instructional design by the consistency principle requires a match between the objective, the learning activity, and the evaluation (Instructional Development Institute, 1972, Wood, 1976, Merrill et al, 1979). This principle can also be mapped onto Hovland's framework as shown in Figure 2. Hovland's four-part question again is represented across the top of the figure. This time, the "what" of the content and "what effect" measured should be isomorphic.

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL

	WHO	WHAT	WHOM	WHAT EFFECT
WOOD		X consistency principle cognitive facts match		X feelings

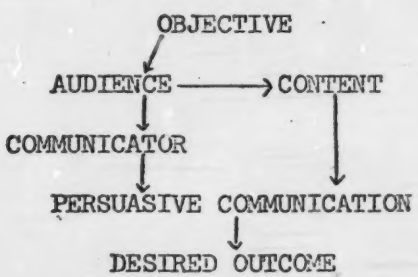
FIGURE 2

THE CONSISTENCY PRINCIPLE MAPPED ONTO HOVLAND'S FRAMEWORK

For the persuasive communication to follow this principle, an elaboration of the relationship between the facts and feelings that comprise one's attitude on a subject needs to be added to the cognitive components described earlier. A second persuasive communication was developed which was made up of the 6 credible communicator characteristics, 6 content components, and an elaboration of the relationship to the four factors that comprise a science attitude.

In this communication, no consideration was given to the "whom" variable except for the assumption that they would be "those preparing to teach science in the elementary school" (Shrigley, 1978, p. 335). One cannot ignore the literature which contends that organismic variables need to be considered in information processing. Cronbach states that "applied psychologists should deal with treatments and persons simultaneously. Treatments are characterized by many dimensions; so are persons . . . We should design treatment, not to fit the average person, but to fit groups of students with particular aptitude patterns. Conversely, we should seek out aptitudes which correspond to . . . modifiable aspects of the treatment" (1957, p. 168).

Following this theory, Hovland's persuasive communication model changes to S-O-R theory and the flow diagram becomes:



As in the S-R model, one begins by defining the specific objective. The audience retains the same influence in determining the credible communicator; although it also contributes to the determination of the content of

the persuasive communication.

Since attitudes are considered to be made up of parts, the cognitive, the affective and the behavioral (Katz and Stotland, 1959, Rosenberg and Hovland, 1960), and since this study was investigating the importance of the consistency principle for affective instruction, integrative complexity (the ability to integrate information and abstract concepts in the environment (Harvey, 1966, Goldstein and Blackman, 1978)), was chosen as the individual difference variable which should have a significant influence on the content of the persuasive communication. The integrative complexity component can be mapped onto Hovland's framework as in Figure 3. Harvey's integrative complexity research clarifies the "whom" since it more carefully describes individual differences across the concrete to abstract spectrum which was left undefined in Shrigley's previous research.

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL

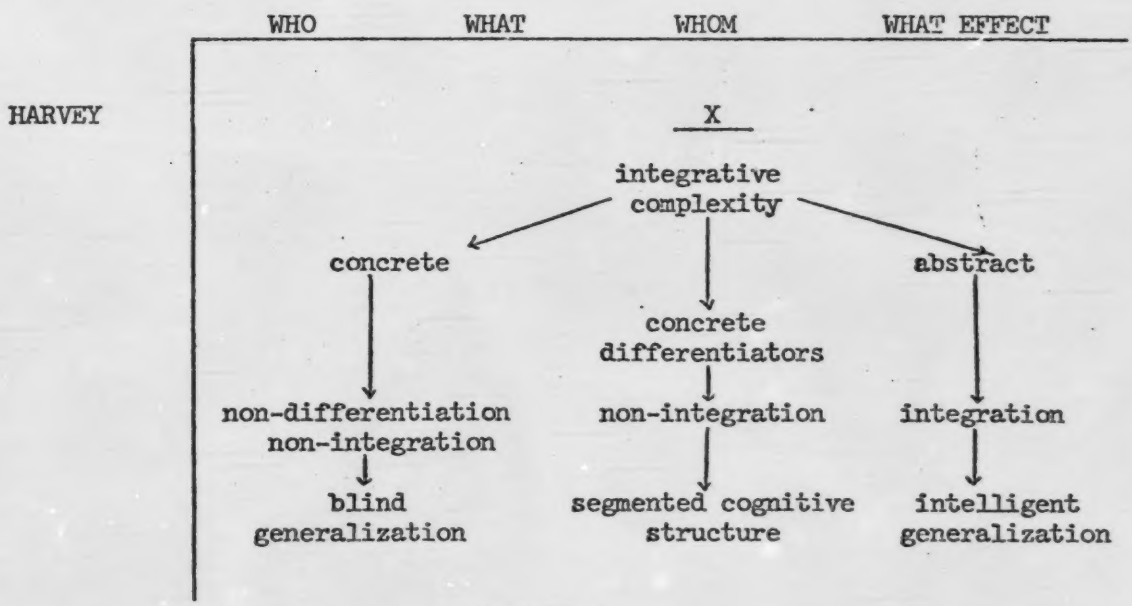


FIGURE 3

THE PLACE OF INTEGRATIVE COMPLEXITY ON HOVLAND'S FRAMEWORK

Differences on the abstract-concrete continuum are explained in terms of differentiation and integration. Concrete subjects who fail to differentiate stimuli of closely related concepts will relate Shrigley's six cognitive elements about the importance of teaching science and their feeling toward science to the four factors that make up their science attitude without it actually stated. Abstract thinkers, who have the ability to differentiate information and integrate it into existing information in their cognitive structure if arguments are plausible will be able to integrate the six components about the importance of teaching science with their feelings toward science (the four factors that make up their science attitude) and thus change their science attitude also (see Figure 4).

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL

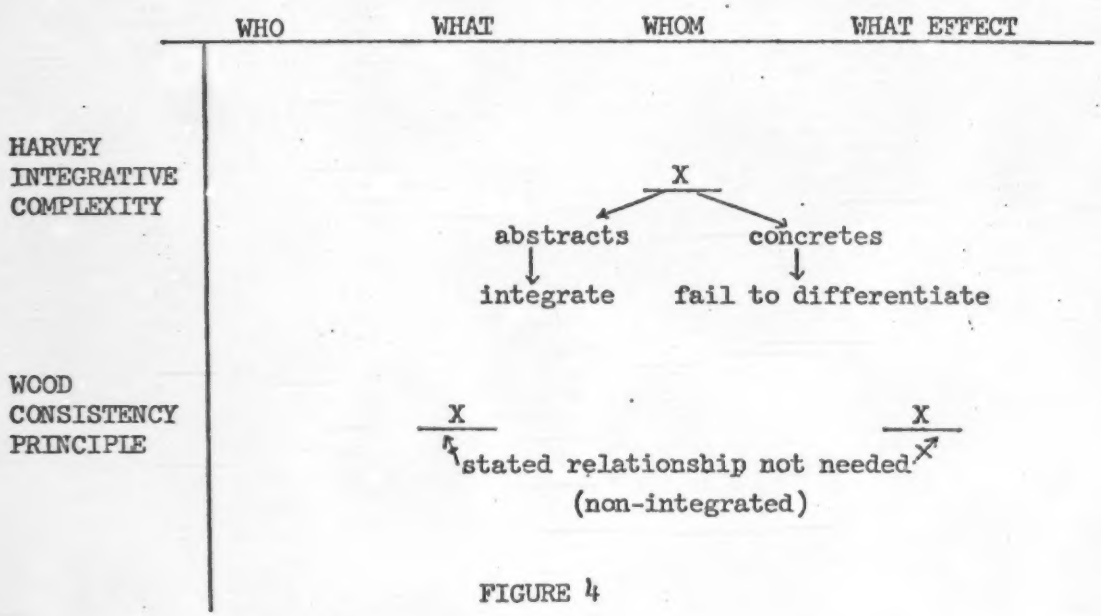


FIGURE 4

THE CONSISTENCY PRINCIPLE AND LEVEL OF INTEGRATIVE COMPLEXITY
FOR ABSTRACT OR CONCRETE THINKERS

Further, it is assumed that these six cognitive elements will not be

sufficient information for changing the science attitude of concrete differentiators who maintain segmented views and do not relate new information into existing unrelated information. The communication would contain sufficient information only to change attitudes about the importance of teaching science in the elementary school. The information and the objective would be consistent and there would be no need for the subjects to integrate the importance of science into their knowledge about general science attitude. However, the objective is to change science attitude, so this cognitive information should not be sufficient to meet the objectives since it does not contain the structurally important relationships (see Figure 5). An additional segment of the persuasive communication which discusses these relationships theoretically should be necessary.

HOVLAND'S PERSUASIVE
COMMUNICATION MODEL

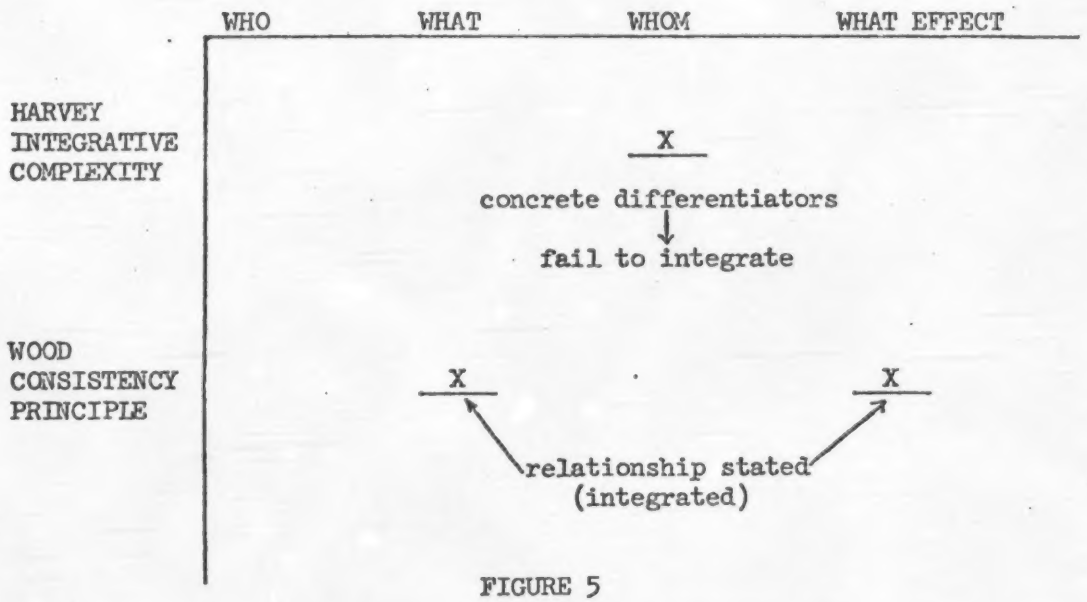


FIGURE 5

THE CONSISTENCY PRINCIPLE AND LEVEL OF INTEGRATIVE COMPLEXITY
FOR CONCRETE DIFFERENTIATORS

Specifically, this study asks the following questions:

1. Do persuasive communications formed from Shrigley's theoretical research change the attitude of preservice teachers toward science?
2. Will an integrated persuasive communication change the attitude of preservice teachers toward science more than a non-integrated persuasive communication?
3. Does integrative complexity mediate the stimulus and response as proposed so that a non-integrated persuasive communication will change science attitude more in some preservice teachers and an integrated persuasive communication will change science attitude more in others?

These questions can be translated into the following hypotheses:

H_1: Preservice teachers who listen to integrated persuasive communications will show significantly more positive change in attitudes toward science than those who listen to no communication.

H_2: Preservice teachers who listen to non-integrated persuasive communications will show significantly more positive change in attitudes toward science than those who listen to no communication.

H_3: Preservice teachers who listen to integrated persuasive communications will show significantly more positive attitudes toward science than those who listen to non-integrated persuasive communications.

H_4: Preservice abstract or concrete thinkers who listen to a non-integrated communication will show significantly more positive change in attitude toward science than those concrete differentiators who listen to the same communication.

H_5: Preservice abstract/concrete thinkers who listen to an integrated treatment will show no more positive change in attitude toward science than the concrete differentiators who listen to the same communication.

H_6: Preservice abstract/concrete thinkers who listen to a non-integrated treatment will show no difference in change in attitude toward science than if they listen to an integrated treatment.

H_7: Preservice concrete differentiators who listen to an integrated persuasive communication will show significantly more positive change in attitude toward science than if they listen to a non-integrated persuasive communication.

A pretest, posttest, control group design was used with subjects block randomized into one of three groups: integrated, non-integrated, or control, by their level of integrative complexity. The Conceptual Systems Test, a 48-item, five choice objective personality test designed by Harvey and Hoffmeister (1978) was used to determine the level of integrative complexity. This test was chosen for several reasons. First of all, the test has been designed by Harvey, who originally conceived the four levels of abstraction and developed the very highly valued This I Believe (TIB) test, and has high content and construct validity (Harvey, 1966). Secondly, it has been designed for group administration of subjects grades seven and over. This test has been used extensively with undergraduates (Epting and Wilkins, 1974). Third, it is a published test and its results may be related to other studies using this instrument. Fourth, it is an objective test which is easier to score than the TIB, another measure of integrative complexity, and not dependent upon subjective evaluation. Fifth, administration of the test takes only 25 - 30 minutes. Sixth, "teachers have been classified according to this scheme in studies of teacher effectiveness" (Buros, 1978, p. 757), and therefore it can be used with preservice teachers who eventually will make up the teacher population.

Upon the recommendation of Hoffmeister (1979), subjects were grouped into low, middle, and high groups with low representing abstract, middle as concrete differentiators, and high as concrete thinkers.

The Shrigley Attitude Scale for Preservice Teachers described previously was used as the pre and post measure of attitude change. A respectable 0.89 and 0.912 coefficient alpha indices of reliability were yielded on the pre and post tests respectively.

Ninety-three volunteers of preservice elementary teachers enrolled in an instructional media course participated in this investigation. Subject distribution is shown in Table 1.

Table 1

Subject Distribution

	TREATMENT A Non-Integrated	TREATMENT B Integrated	TREATMENT C Control	Total
High	8	9	8	25
Middle	15	18	15	48
Low	4	3	5	12
Subtotal	27	30	28	85
Unclassifiable	4	2	2	8
Total	31	32	30	93

The non-integrated treatment was a videotaped discussion of the 6 cognitive components with the weaving in of the 6 statements to establish communicator credibility. The integrated treatment was also a videotaped discussion as in the non-integrated treatment with an additional segment which discussed the relationship between the importance of science teaching and one's feelings toward science. To determine if the two persuasive communications were effective in changing attitudes of preservice teachers, a 3X2 analysis of variance with repeated measures with three levels of treatment, integrated, non-integrated and control as the between subjects A factor and the pre and post-test scores as the within subjects J factor. Results are shown in Table 2 and Figure 6.

Table 2

Summary Table for Comparing Pre- and Post-test Scores Across the Three Treatment Conditions

Source of Variation	Sums of Squares	Mean Squares	df	F-Ratio
Between Subjects (A)	565.30	282.65	2	1.138
Error	22357.51	248.42	90	
Within Subjects (J)	149.94	149.94	1	7.47 **
AJ	129.10	64.55	2	3.22 *
Error	1806.46	20.07	90	

*p .05

**p .01

	PRE	POST
(A) Non-Integrated	65.19	68.39
(B) Integrated	62.65	65.34
(C) Control	62.26	62.65

FIGURE 6

These results show a significant interaction, so three tests of contrasts comparing the pre- and post-scores of each treatment were conducted. Family-wise error has been controlled using the Tukey WSD on the follow-up tests. Results of this analysis are shown in Table 3.

Table 3

Follow-up Test Results Comparing Pre- and Post-Test Scores on the Three Treatments

Pre-Post Contrast	Difference	Obtained T	df	Critical Value of T
Non-Integrated	3.1935	3.468 *	30	2.04
Integrated	2.6875	2.224 *	31	2.04
Control	0.6000	0.477	29	2.05

*p .05

These results indicate a significant difference between the pre- and post-test scores of both the non-integrated treatment group and the integrated treatment group.

The relationships among the concretes, concrete differentiators, and abstract groups in the three treatments were also investigated.

Due to the theoretical prediction that both concretes and abstracts would manifest a greater attitude change than the concrete differentiators, and the dearth of samples on each extreme, the two groups were combined into

the 'high' group to increase the power of discrimination between cell means. Concrete differentiators remained intact and will be called the 'medium' group.

Analysis of variance with repeated measures in a 3X2X2 design with three treatments, two levels of integrative complexity, and pre- and post-measures was used to test these last four hypotheses. Since proportional sample sizes were needed to run this analysis, three subjects had to be randomly eliminated from the medium, integrated group and one subject randomly eliminated from the high, control group. Proportionality thus was achieved with 12 subjects in the high, and 15 subjects in the medium groups across each treatment condition.

The results designated in Table 4 reveal neither a triple interaction nor any two-level interactions. The within-subjects variable was significant as expected and consistent with the findings in Table 2. Of interest to this analysis was the difference in pre- and post-scores among each level of integrative complexity and treatment. Since no triple interaction resulted, significant differences between pre- and post-scores on both levels of high and medium integrative complexity in each treatment were examined. Results of this analysis are recorded in Table 5. Differences are shown in Figure 10.

Table 4

Summary Table for Testing the Individual Difference Variable

Source of Variation	Sums of Squares	Mean Squares	df	F-Ratio
Between Subjects				
(A) - 3 Treatments	655.05	372.52	2	1.482
(B) - High-Medium	12.22	12.22	1	0.055
(AB) - Interaction	469.29	234.64	2	1.061
Error	16580.19	221.07	75	
Within Subjects				
(J) - Pre-Post	160.01	160.01	1	8.632 **
(AJ) - Interaction	58.38	29.19	2	1.575
(BJ) - Interaction	5.96	5.96	1	0.322
(ABJ) - Interaction	14.99	7.49	2	0.404
Error	1390.16	18.54	75	

**p .01

Table 5

Follow-up Tests for Comparing Pre- and Post-Scores
for High and Medium Groups in Each Treatment

Pre-Post Contrast	Difference	Obtained T	df	Critical Value of T
High, Non-Integrated	4.3333	3.916 *	14	3.155
Medium, Non-Integrated	1.8667	1.182	14	3.155
High, Integrated	2.8333	1.166	14	3.155
Medium, Integrated	2.6000	1.809	14	3.155
High, Control	0.0833	0.057	14	3.155
Medium, Control	0.4667	0.297	14	3.155

*p .05

	Non-Integrated		Integrated		Control	
	Pre	Post	Pre	Post	Pre	Post
High	61.67	66.00	63.58	66.42	62.00	62.08
Medium	68.00	69.87	60.53	63.13	61.53	62.00

FIGURE 7

COMPARISON OF PRE- AND POST-SCORES FOR HIGH AND
MEDIUM GROUPS IN EACH TREATMENT

Non-integrated and integrated treatment data indicate that a more positive attitude resulted after listening to the persuasive communication; however, only the difference for the high subjects in the non-integrated treatment condition was significant.

These results indicate for the other groups that the changes in attitude were not significantly different from each other, although the gain scores were in the predicted direction.

Discussion and Critical Analysis of Results

Support has been found for the predicted change in attitude after listening to the integrated treatment or non-integrated treatment but not for the control group. These results indicate that Shrigley's theoretical

example of a systematically designed persuasive communication using Hovland's model can yield a positive change in attitude toward science. The communicator and communication components which made up both the integrated and non-integrated treatments can now be interpreted as essential and effective in bringing about an attitude change.

The predicted difference between the non-integrated and integrated treatment attitude scores was not supported even though the integrated treatment was designed according to the consistency principle, that is, by adding four components, which directly matched the type of questions on the evaluation instrument (Shrigley Attitude Scale for Preservice Teachers), to the content of the non-integrated persuasive communication. These results indicate that the inclusion of the additional section to the persuasive communication which explicitly establishes the relationship between attitude toward science and the factors which make up one's attitude toward science is not necessary.

The sensitivity one has to having one's attitude changed cautions instructional designers against including statements which specifically mention audience attitudes. Statements which declared that the communicator was trying to manipulate the audience's attitude were carefully avoided; however, descriptions of how their attitude on the four factors related to their science attitude were explicit. The mention of attitudes, combined with administration of a science attitude pre-test may have cued, or established a predisposed resistance to the message. This may mean that in a persuasive communication one-to-one correspondence in instruction-evaluation may not be desirable. It should be noted that the effects of the additional segment in the integrated treatment did not prevent a positive change in attitude from occurring. What is also important to note is that the six

components of the non-integrated treatment were included and may have caused the change in attitude in spite of the negative effects possible caused by mentioning attitudes.

Due to the fact that the abstract and concrete thinkers were predicted to obtain the same results, the former because of intelligent differentiation and integration and the latter because of lack of differentiation, both were combined in order to compare their results with the results of the concrete differentiators across pre- and post-test scores as posed in hypotheses 4 through 7. After calculating the analysis of variance with the combined group, difference was found between pre- and post-scores for only the high abstract/concrete, non-integrated treatment group. In analyzing these individual difference results, it is important to keep in mind the predictions for each cell which are shown in Figure 8.

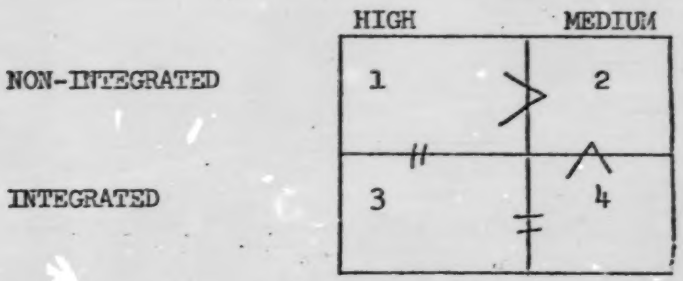


FIGURE 8

PREDICTED RESULTS FOR THE INDIVIDUAL DIFFERENCE VARIABLE

According to the manner in which concretes, abstracts, and concrete differentiators differ in their cognitive processing, high subjects who listen to the non-integrated treatment should have a greater change in attitude than concrete differentiators, medium subjects, who listen to the same communication. The one-to-one correspondence between the communication and evaluation advocated by the consistency principle is not

needed to change attitudes for this high group. Cells 1 and 3 from Figure 8, therefore, should be equal since these relationships are not, in fact, present in the non-integrated treatment (cell 1) and are present, although not necessary, in the integrated treatment (cell 3).

The one-to-one correspondence of the consistency principle, however, was predicted to be essential in designing instruction for concrete differentiators because of their segmented cognitive structure. This means that cell 4 should reflect a greater change in attitude than cell 2 since the concrete differentiators were presented with integrated information. The integrated treatment should yield equal results in cells 3 and 4 for both high and medium groups since relationships were established for both those who fail to differentiate or integrate and those who do not.

The results indicate a significant change in attitude in cell 1 from Figure 8, but not for any of the others. This means that for the high integrative complex subjects, the persuasive communication may be designed based on Shrigley's work without one-to-one correspondence of the instruction and evaluation. For the other cells, stated relationships may or may not be needed to elicit a significant change in attitude by means of a persuasive communication.

To determine if the integrated treatment was more effective than the non-integrated treatment for either level of integrative complexity, analysis of variance was applied to the gain scores. No significant difference resulted between the means. Although all of the means in each cell were in the predicted direction, the high variance in each cell reduced the power of the test to detect any differences. Based on this analysis, it is important to emphasize that the cell means cannot be legitimately attributed to different populations, and are not, therefore, statistically different from each other. Retesting this hypothesis with a larger sample representing the abstract and concrete groups is essential to determine if

the consistency principle should be followed in developing different persuasive communications for different levels of integrative complexity.

These results, indicating equality in the cell means, are inconsistent with the theoretical basis of cognitive processing in concrete-abstract thinkers. Considering all the research conducted in defining the characteristics of concrete/abstract thinkers and the significant results showing that Shrigley's six components elicit a positive attitude change, it is unlikely that non-significance can be attributed to faulty definition of the subjects by integrative complexity. Rather, careful inspection of the content of the additional segment in the integrated treatment which discusses the relationship between the importance of teaching science and the four affective factors that make up one's attitude toward science is warranted. Examples used in establishing relationships in the treatment must be examined to determine if they are significantly relevant to the audience. If relevance of the examples cannot be established, they should be changed. Also, the mention of attitudes in the integrated persuasive communication must be tested to determine if the treatment is cueing the audience to the objective of the treatment. Changes in the additional segment of the integrated communication should be made and tested before any significant conclusions are drawn about applying the consistency principle to the design of a persuasive communication for subjects differing in level of integrative complexity.

Conclusions

Presentation of the persuasive communication resulted in a change in attitude for both the integrated and non-integrated treatment groups. There was no significant difference in the magnitude of the change in

decrease between the non-integrated and integrated groups, both treatments apparently being equally as effective. Differences between treatments, pre- and post-scores, and level of integrative complexity were analyzed next. In order to examine the results more closely, concretes and abstracts were combined into the high group and compared to the concrete differentiators (the medium group). The statistical tests indicated that the only group to achieve a significant gain in attitude was the high subjects who listened to the non-integrated communication. The high, non-integrated group's gain score, however, cannot be said to be significantly greater than that of any other group.

Implications of the Study

This study has shown the empirical effectiveness of Shrigley's theoretical science persuasive communication. The combination of the essential components of a persuasive communication and the establishment of the perceived credibility of the communicator resulted in significant positive change in attitude. The importance of this result touches several important areas. First of all, the results indicate that science attitude, in fact, can be changed. Knowing this may be the first step in increasing the amount of science teaching occurring in the elementary school.

Next, contrary to common opinion, science attitudes can be changed with as little as a twenty-minute persuasive communication. This is especially important in dealing with in-service programs for teachers. Time is very critical with these programs as they are typically very short, one-day sessions.

Finally, but most importantly for instructional development models, support is indicated for designing a persuasive communication using the systematic strategy of investigating each piece of Hovland's framework

as Shrigley did.

Further investigation needs to be conducted to determine if the consistency principle needs to be followed in designing a persuasive communication to elicit a change in attitude for the concrete differentiators; if it is necessary for the design of persuasive communications for high abstracts or concretes; and if matching instruction to evaluation really interferes with attitude change because of the direct way it presents information and relationships (in this case, between attitudes and behaviors).

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